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RBA: Integrated EEG Stimulation and Recording System for Electrical and Acoustical Stimulation

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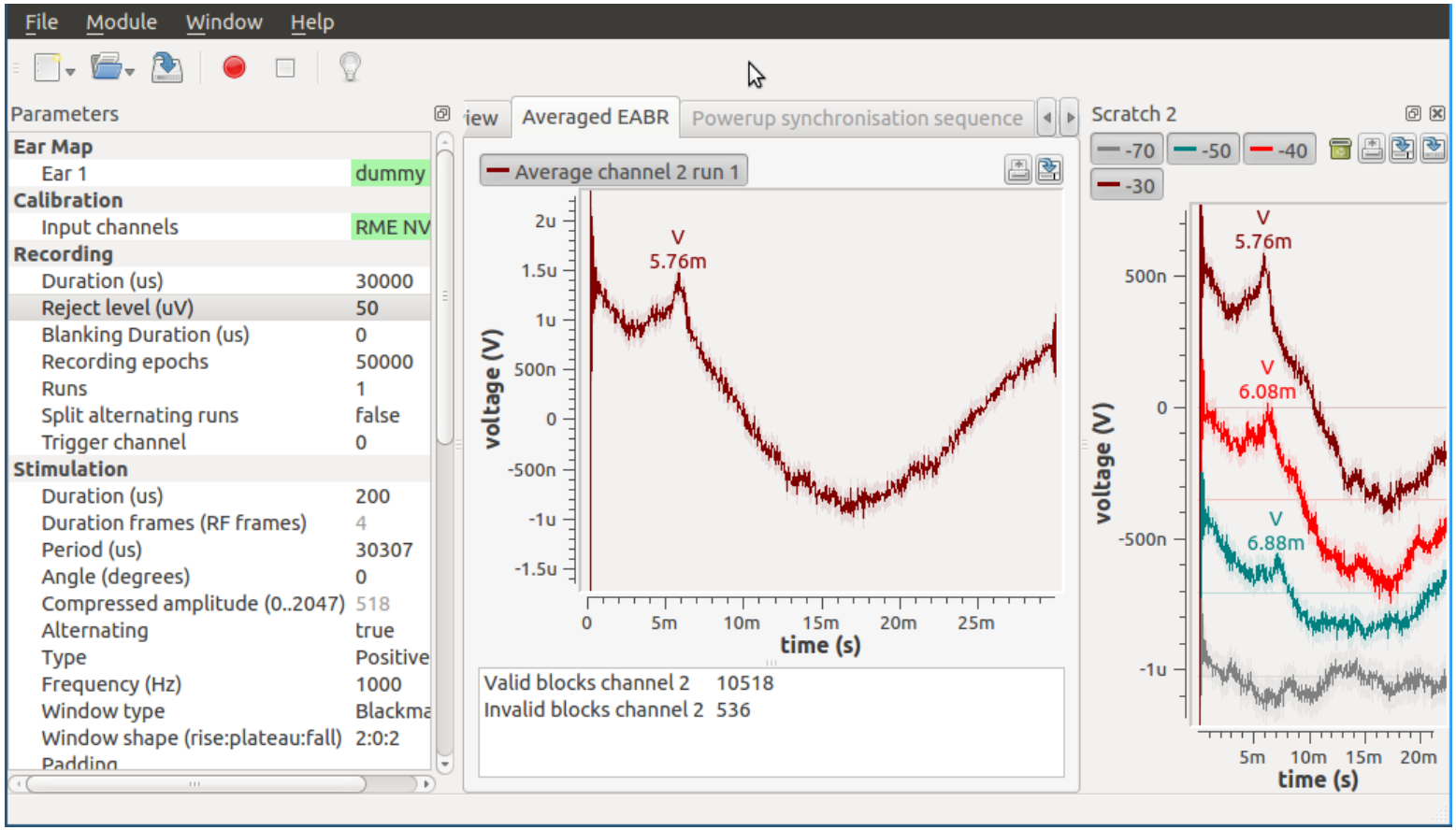
Overview: RBA



- Integrated EEG stimulation, recording and analysis for AEP
- Used for all EEG research at ExpORL

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Why not Python/MATLAB/Presentation/...

(Randall Munroe, xkcd 927)

Why not Python/MATLAB/Presentation/...

- One software platform for all EEG research
  - Avoid to reimplement the wheel
- Open source, free software
- Normally no programming required
- Provide the boring parts:
  - Management of experiments, stimulation and recording
  - Interactive specification of parameters, e. g. amplitude, frequency
  - On-line display of results in plots and tables

Features: Stimulation

- Acoustic stimulation
  - Internal or external sound card
  - 8 channels for two ears and external triggers
- Electrical stimulation
  - Cochlear NIC and Advanced Bionics BEDCS
- Calibration
  - Graphical interface
- Patient thresholds and fitting
  - Protect against overstimulation
  - Profiles per subject and task

Features: Recording and Analysis

Recording

- Multi-channel medical preamplifier connected to sound card
- External trigger

Analysis

- Analysis: filtering $\rightarrow$ artifact rejection $\rightarrow$ averaging
- Reanalysis with different parameters: artifact rejection, ...

Display

- Preview of stimulus
- On-line results: response shape, spectrum, statistics
- Interactive display and annotation of multiple responses

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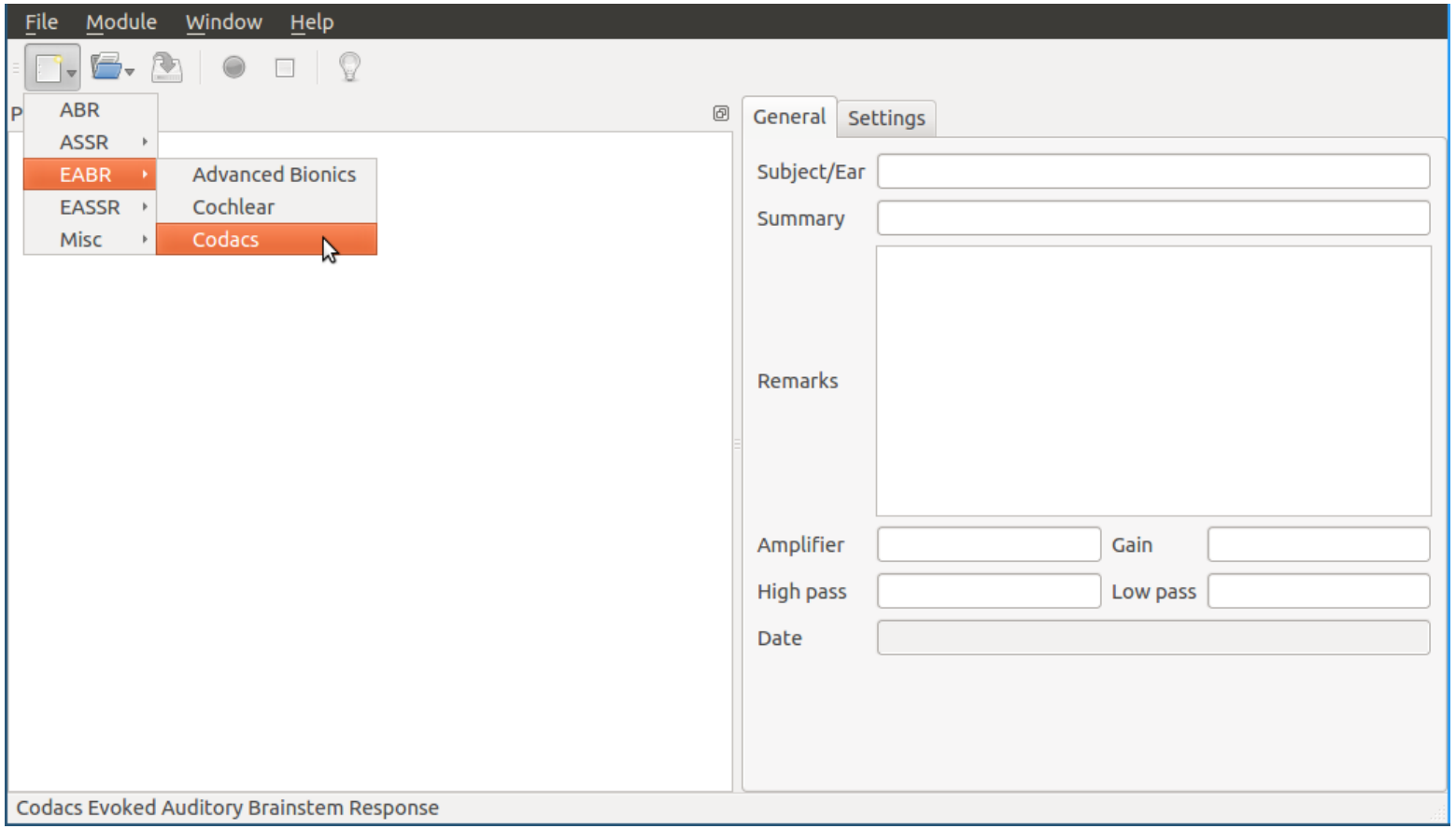
Example

Prepare experiments



- Select module for paradigm

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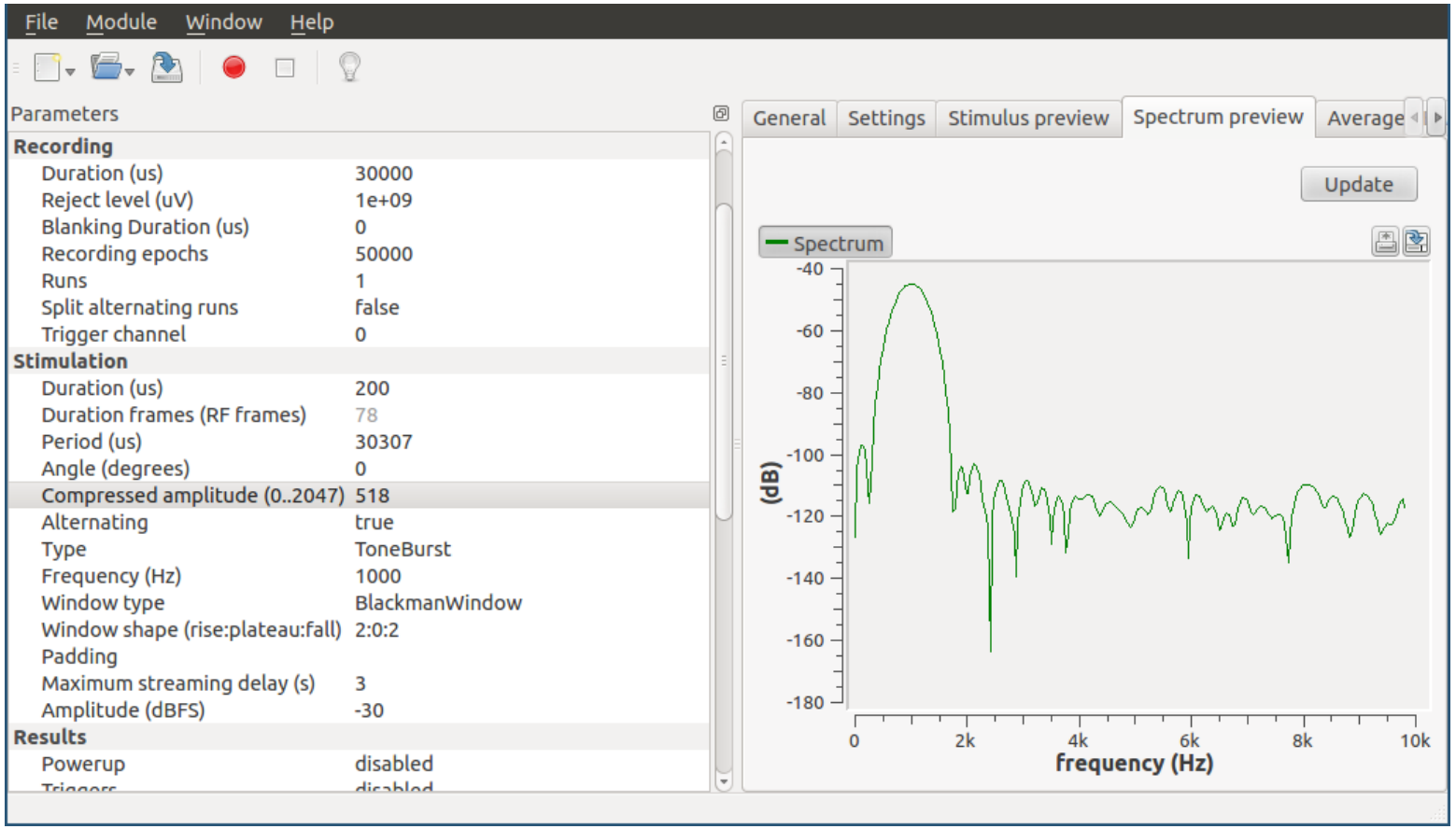
Example

Prepare experiments



- Select module for paradigm
- Configure experiment parameters

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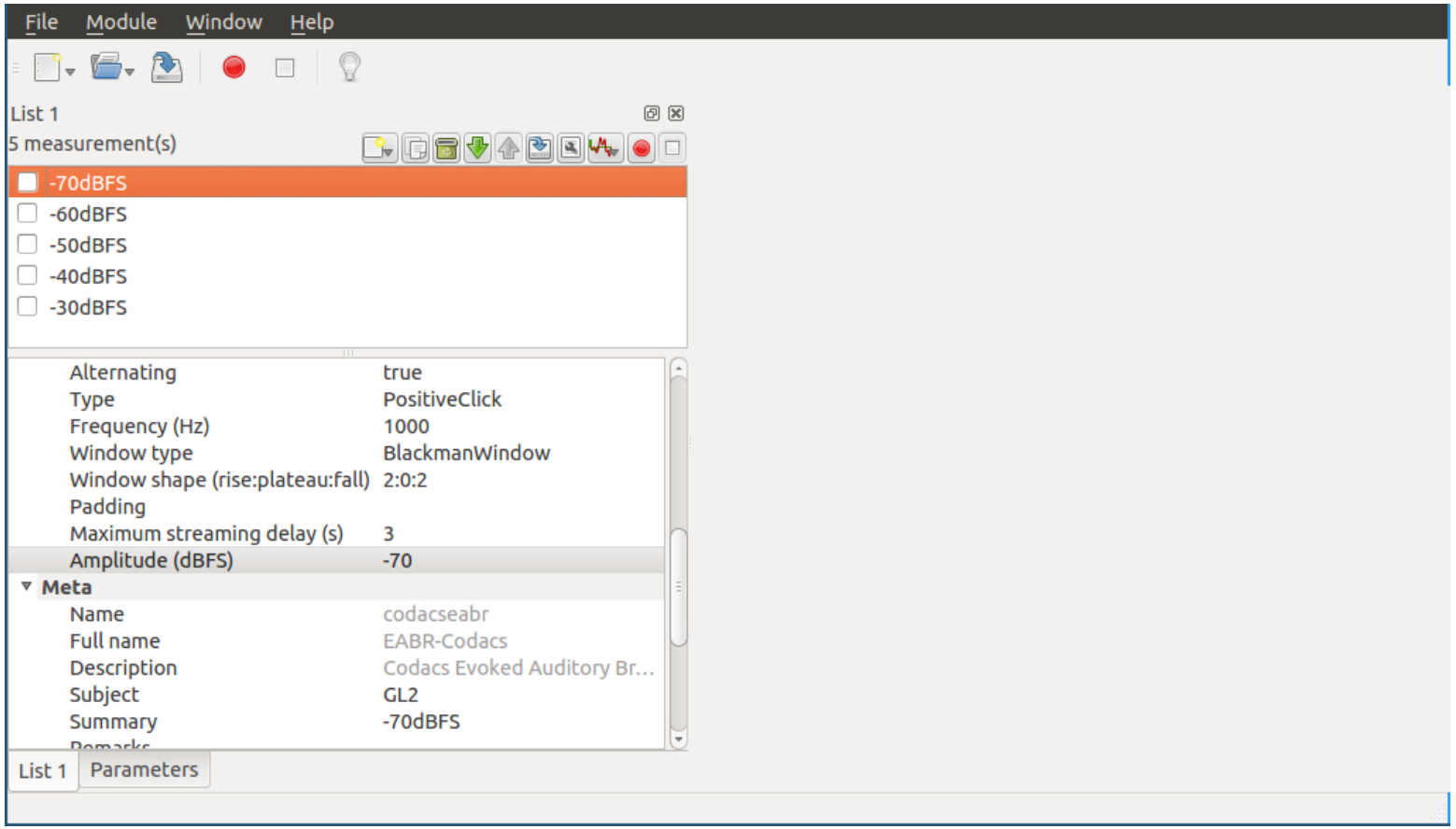
Example

Prepare complete sessions



- Automatic recording of multiple successive experiments
- Preparation of additional experiments during ongoing recording

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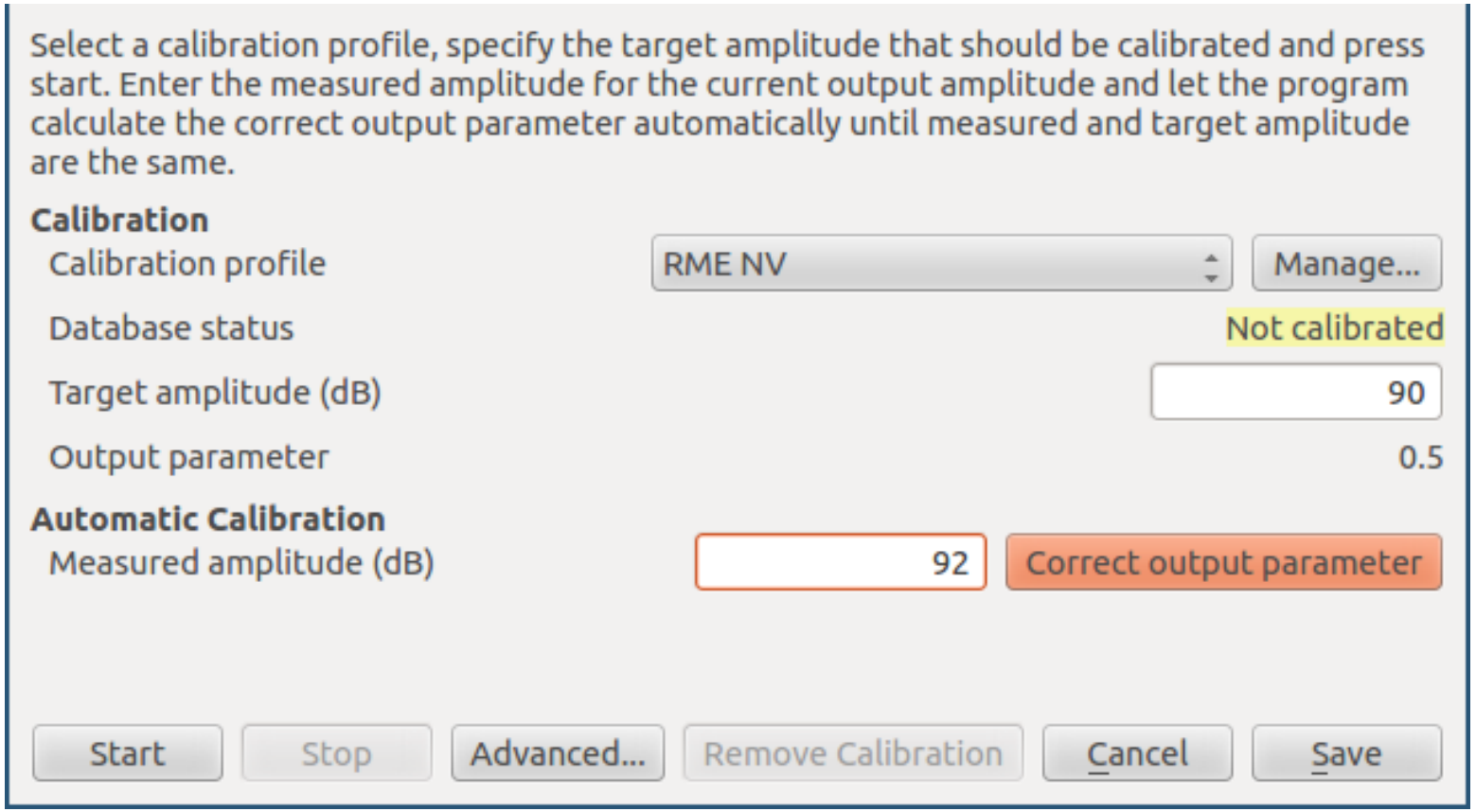
Example

Calibration, hearing thresholds and CI fitting



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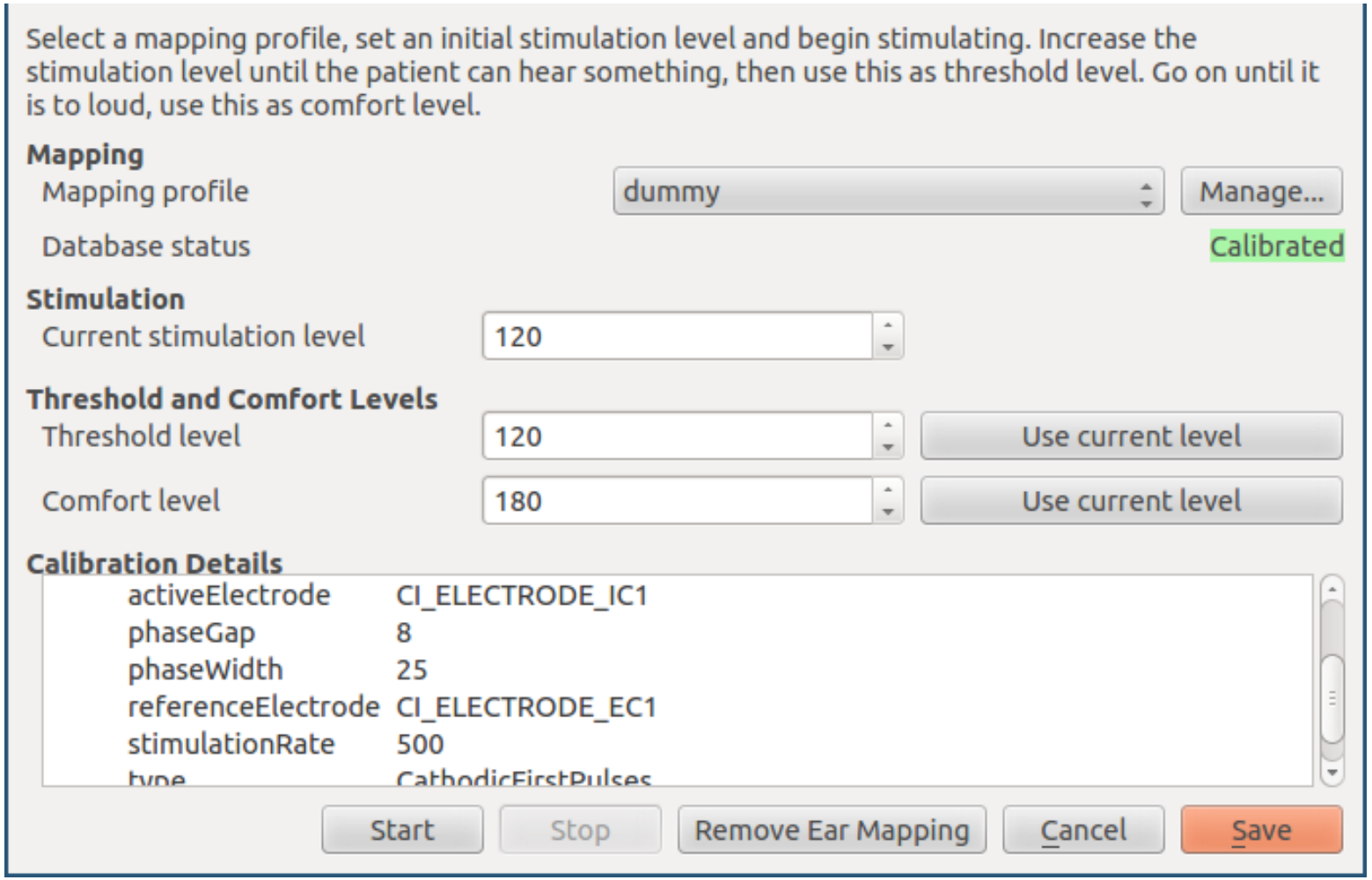
Example

Calibration, hearing thresholds and CI fitting



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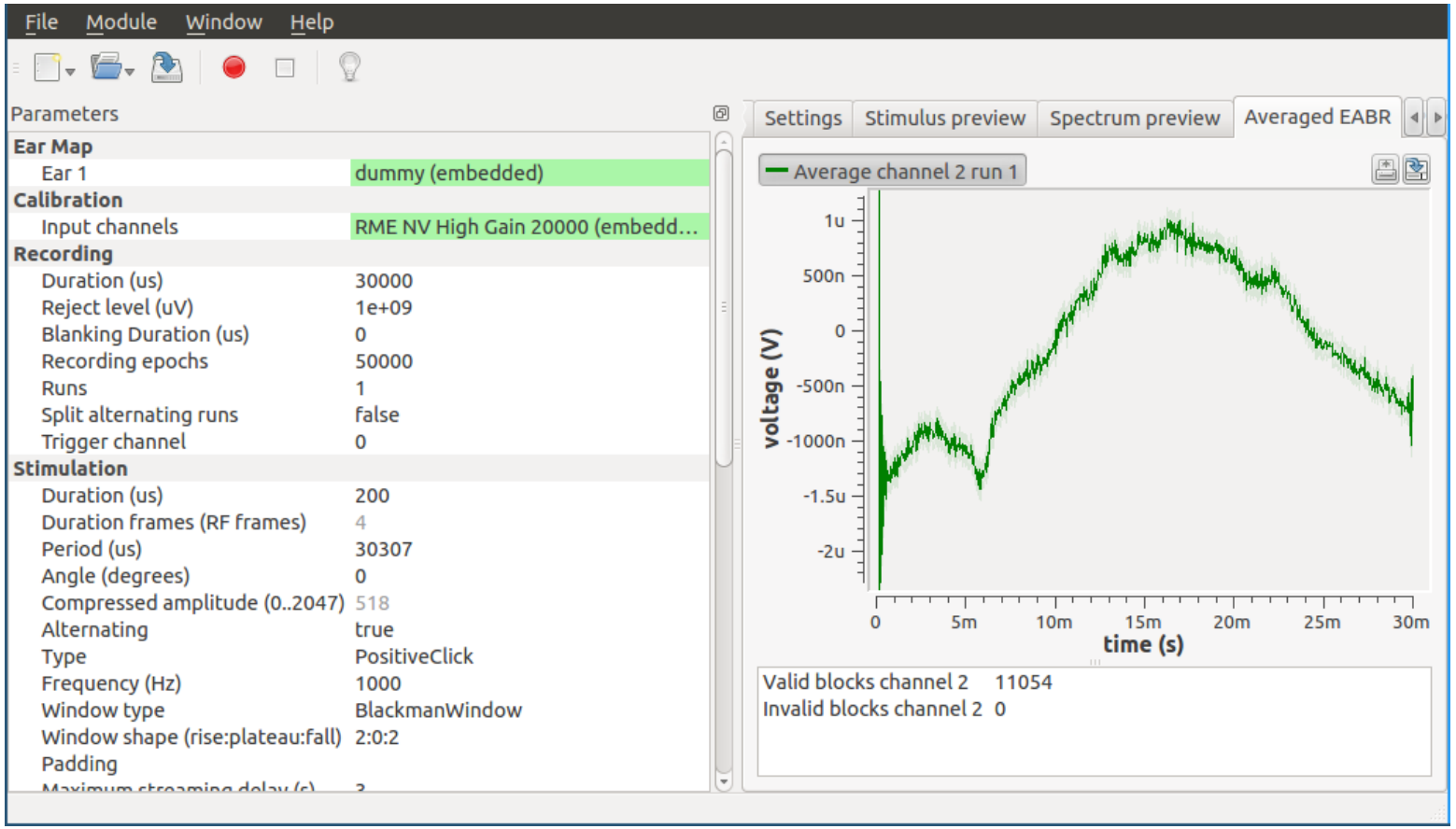
Example

Recording and analysis



- On-line analysis

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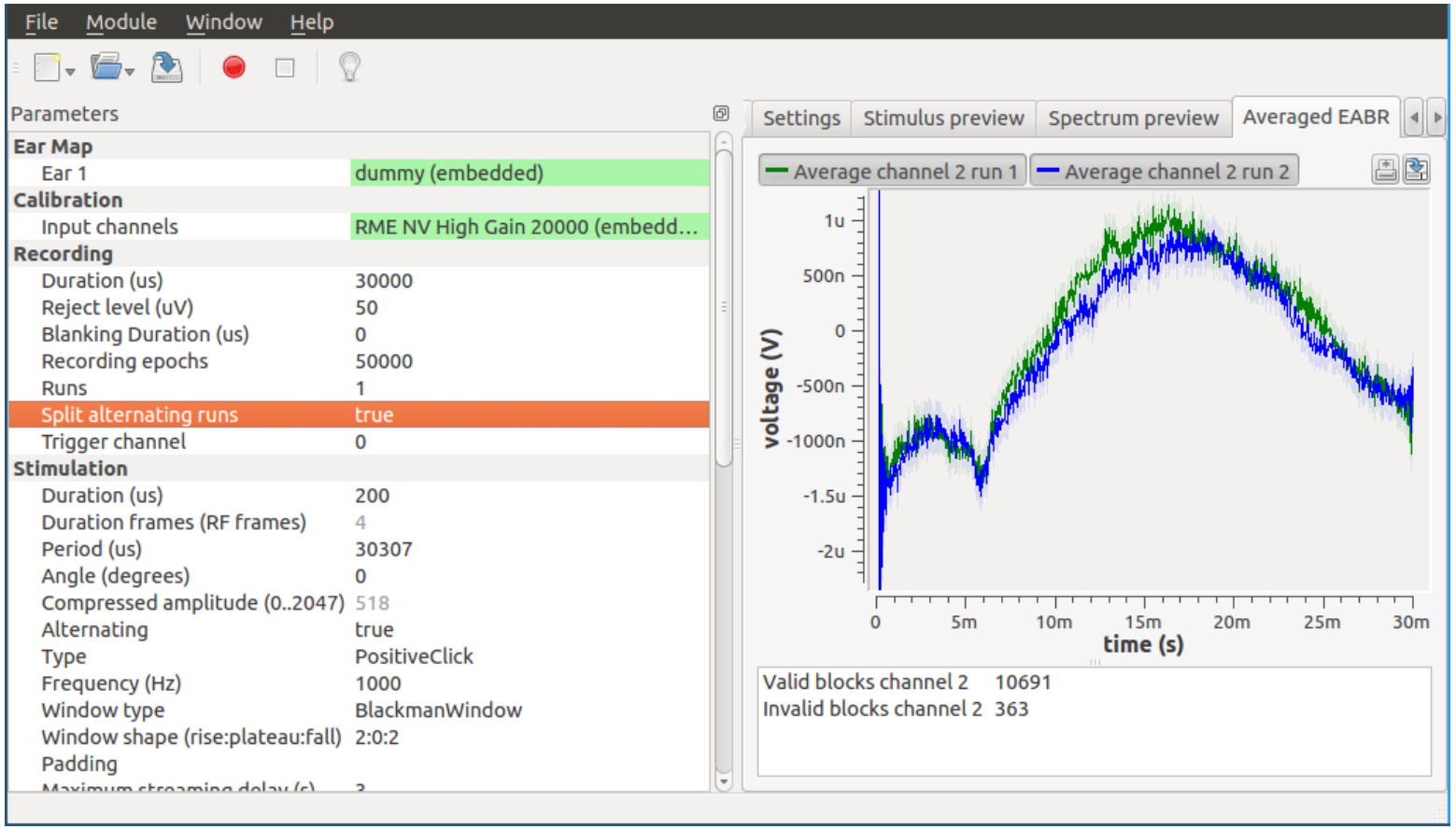
Example

Recording and analysis



- On-line analysis
- Ad-hoc parameter changes

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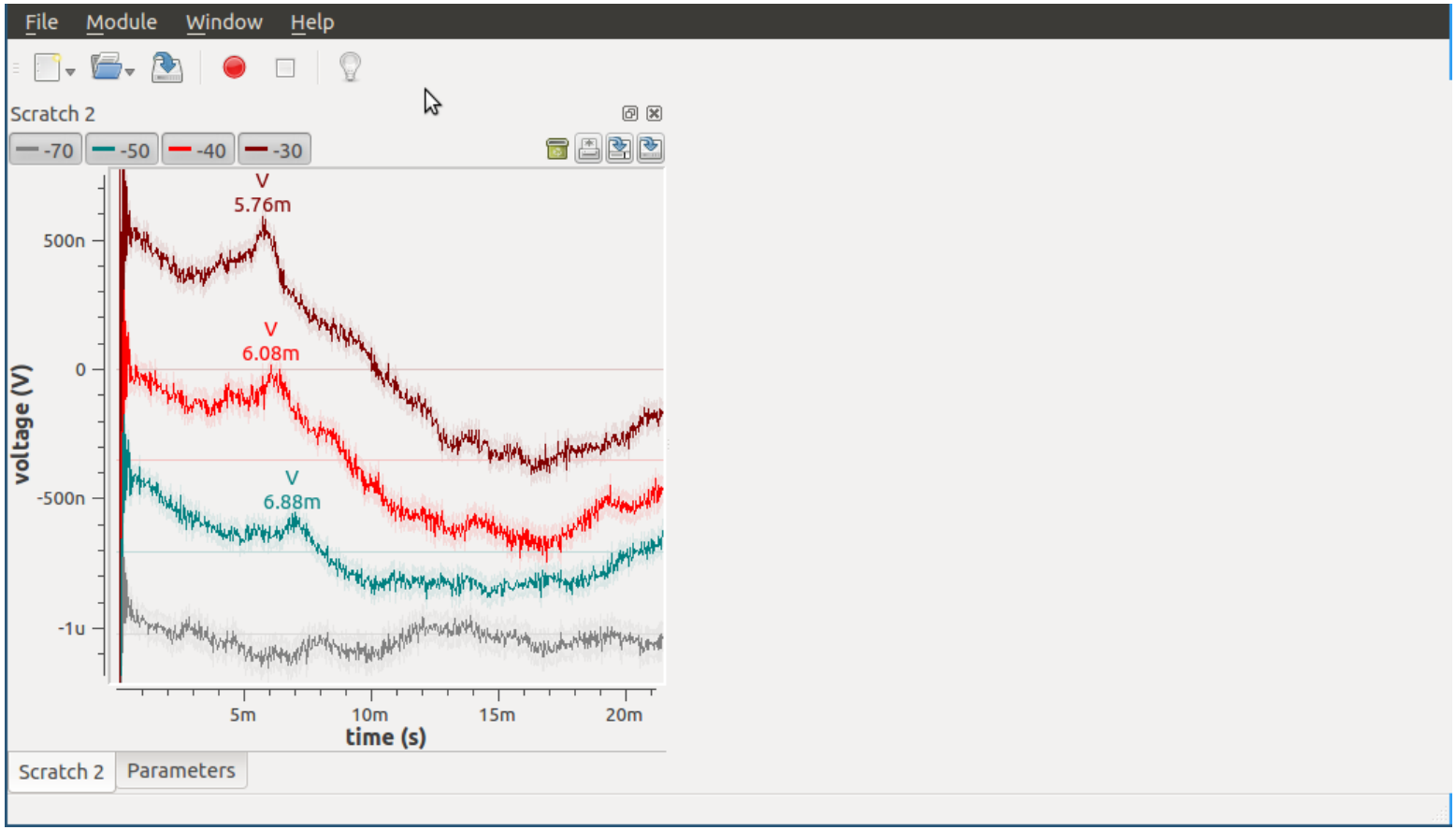
Example

Post-processing



- Compare and annotate

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Example

Data storage

- Recorded EEG: wave files
- Meta data: XML-in-ZIP

```
000/                      - first experiment
    meta.xml              - sample rate
    calibrations.xml      - 80dB ~ gain 0.5
    stimulation.xml       - 40 Hz click train
    recording.xml         - 5% artifact rejection
    recording.wav         - EEG data
001/                      - more experiments
    ...
```


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Export and post-processing

- MATLAB toolbox to read EEG and meta data

```
s = biopil_raw_data('FileName', 'test.rbadata');
s = biopil_rba_data(s);
s = biopil_epochs(s);
```


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Example

Export and post-processing

- MATLAB toolbox to read EEG and meta data

```
s = biopil_raw_data('FileName', 'test.rbadata');
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```

```
disp(s.RbaData.EpochLength)
disp(s.RbaData.StimulationFrequency)

plot(mean(s.Epochs.EegData, 2))
```


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Summary and Conclusions

- Stimulation, recording, analysis
- Modules for most common tasks: (E)ABR, (E)ASSR, ...
- Requirements:
  - Linux, Microsoft Windows
  - EEG preamplifier
- Binaries and source code available under the GPL
  - under the condition of a research cooperation
- Paper in preparation